CMWR 2008 STUDENT FELLOW AWARDEE

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TITLE: Pore Scale Simulation of Two-Phase Flow through Fractures in Porous Media

ABSTRACT

The flow of immiscible fluids through natural fractures in a heterogeneous porous rock matrix is controlled by pore- and fracture geometry, fracture aperture, interfacial forces and fluid and capillary pressure gradients. While much work has been done on flow in fractures in non-porous materials, there is a lack thereof for porous media fractures.

Commonly, two-phase flow in fractures is modelled using a relative permeability saturation relationship, kri(sw). Originally, this formulation included a flow rate-dependency (e.g. Barenblatt 1960) which currently is largely ignored in spite of considerable evidence for it (e.g. Chen et.al. 2004). Furthermore, cross terms in the original formulation suitable for a consideration of the viscous drag among flowing fluid phases are also usually neglected although experimental data show otherwise (e.g. Fourar et al. 1993).

In this work, I will develop a first principle-based numerical simulation method based on a discrete representation of both fractures and pore space. This will eventually allow to place new constraints on kri by making it possible to analyze separately the flow of individual phases across matrix and fracture void space.

My work in progress has thus far validated a two-dimensional pore scale model for the case of single phase flow, including automatic determination of pore diameter and maximum pore capillary pressure. This has allowed me to estimate effective permeability and capillary pressure curves from thin section micrographs and micro-CT scan of selected porous media. Future work is now being directed at describing the interplay of multiphase flow processes in complex heterogeneous fractured porous media.

Citation: Barenblatt 1960, Basic Concepts in the Theory of Seepage of Homogeneous Liquids in Fissured Rocks (Strata) PMM Vol 24 852-864; Chen et. al. 2004, Experimental study of liquid-gas flow structure effects on relative permeabilities in a fracture WRR 40 W08301 doi:10.1029/2004WR003026, Fourar et al. 1993, Two-phase flow in smooth and rough fractures: Measurement and correlation by porous-medium and pipe flow models, WRR 29, 3699-3708.